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ULTRACAM photometry of the ultra-compact binary V407 Vul

T.R. Marsh¹, V.S. Dhillon², D. Steeghs³, S.C.C. Barros¹, P. Groot⁴,
G. Nelemans^{5,4}, G. Ramsay⁶, and G. Roelofs⁴

¹ *Department of Physics, University of Warwick, Coventry CV4 7AL, UK*

² *Department of Physics and Astronomy, University of Sheffield, Sheffield S3 7RH, UK*

³ *Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA*

⁴ *Department of Astrophysics, University of Nijmegen, P.O. Box 9010, 6500 GL Nijmegen, NL*

⁵ *Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK*

⁶ *Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking RH5 6NT, UK*

Abstract. V407 Vul is a 20th magnitude star that varies on a period of 570 seconds at both X-ray and optical wavelengths. Its properties lead Cropper et al (1998) to suggest that this is the orbital period of two white dwarfs. We present photometry of V407 Vul taken simultaneously in u' , g' and i' . We find that the pulsations are progressively delayed when one moves to shorter wavelengths. We find no modulation in the position of V407 Vul on the sky, indicating that the G/K star in its spectrum is less than 0.03 arcseconds on the sky away from the variable.

1. Introduction

There are currently several competing models of the so-called ultra-compact V407 Vul (see Nelemans, these proceedings). All have problems, but they do approximately explain the known facts about the star, and so the ball is in the observer's court as far as distinguishing between them. This paper presents the first simultaneous multi-colour optical photometry taken as part of the effort to pin down this star.

2. Observations

We took 3762 exposures of V407 Vul each of 9.7 seconds each, with 0.024 seconds dead-time between exposures on the 4.2m William Herschel Telescope using the high-speed camera ULTRACAM over the nights 21-25 May 2003. The mean magnitudes of V407 Vul were $i' = 18.9$, $g' = 20.3$, $u' = 21.3$. They were reduced with the ULTRACAM pipeline software. Data of poor seeing were weeded out because the field of V407 Vul is fairly crowded.

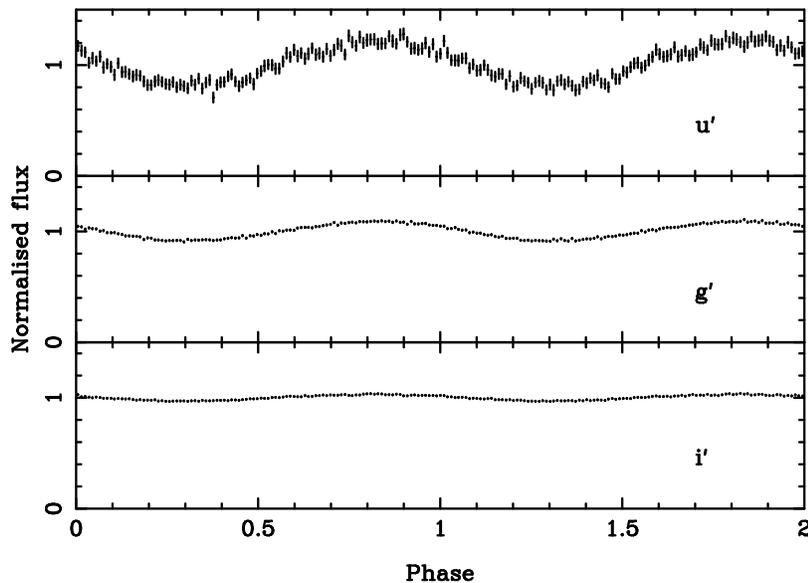


Figure 1. Phase-folded and binned light-curves of V407 Vul in u' , g' and i' .

3. Results

The phase-folded (ephemeris from Strohmayer (2004)) and binned data are shown in Figure 1. Relative to i' , the phases are $i' = 0.0 \pm 1.8$ sec, $g' = 4.2 \pm 1.1$ sec, $u' = 7.2 \pm 2.4$ sec. Thus there is an indication that the phase is progressively delayed towards shorter wavelengths. This could result from a trail of cooling gas downstream from an accretion spot on the white dwarf, as is expected in the direct impact model for example (Marsh & Steeghs 2002). However, the significance of this is very marginal: an F -ratio test comparing a constant versus a linear change of phase with wavelength indicates that there is $\sim 11\%$ chance that this could be caused by random variations alone.

The optical spectrum of V407 Vul is dominated by a late-G/early-K star (Steeghs et al., in preparation). This may be a line-of-sight coincidence as the field is crowded. Our ULTRACAM data put an upper limit of 0.03 arcseconds upon the maximum separation on the sky between this star and the variable from the lack of variation in the position of V407 Vul on the 570 second pulsation period.

Acknowledgments. TRM thanks PPARC for support under a Senior Research Fellowship; SCCB was supported by Fundação para a Ciência e Tecnologia e Fundo Social Europeu no âmbito do III Quadro Comunitário de Apoio.

References

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